

N-Channel Power MOSFET 13A, 600Volts

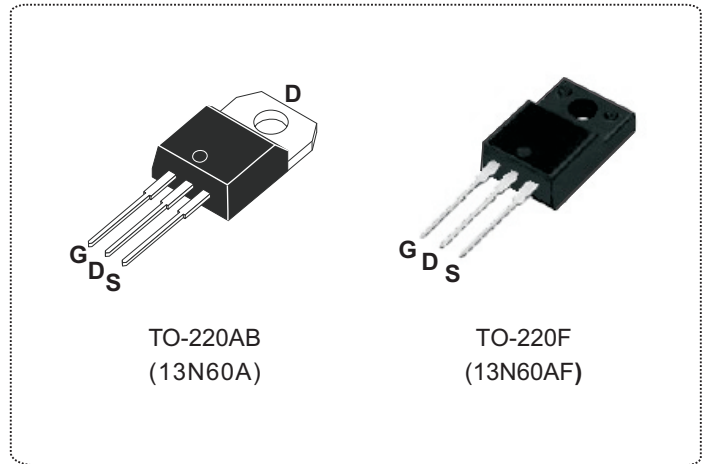
DESCRIPTION

The Nell **13N60** is a three-terminal silicon device with current conduction capability of 13A, fast switching speed, low on-state resistance, breakdown voltage rating of 600V, and max. threshold voltage of 4 volts.

They are designed for use in applications such as switched mode power supplies. DC to DC converters, **PWM** motor controls, bridge circuits and general purpose switching applications.

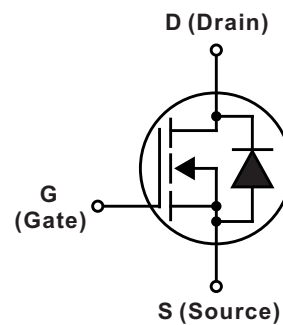
FEATURES

- $R_{DS(ON)} = 0.26\Omega @ V_{GS} = 10V$
- Ultra low gate charge(40nC max.)
- Low reverse transfer capacitance ($C_{RSS} = 3pF$ typical)
- Fast switching capability
- 100% avalanche energy specified
- Improved dv/dt capability
- 150°C operation temperature



TO-220AB
(13N60A)

TO-220F
(13N60AF)



PRODUCT SUMMARY	
I_D (A)	13
V_{DSS} (V)	600
$R_{DS(ON)}$ (Ω)	0.26 @ $V_{GS} = 10V$
Q_G (nC) max.	40

ABSOLUTE MAXIMUM RATINGS ($T_C = 25^\circ C$ unless otherwise specified)				
SYMBOL	PARAMETER	TEST CONDITIONS	VALUE	UNIT
V_{DSS}	Drain to Source voltage	$T_J = 25^\circ C$ to $150^\circ C$	600	V
V_{DGR}	Drain to Gate voltage	$R_{GS} = 20K\Omega$	600	
V_{GS}	Gate to Source voltage		± 30	
I_D	Continuous Drain Current	$T_C = 25^\circ C$	13	A
		$T_C = 100^\circ C$	8.2	
I_{DM}	Pulsed Drain current(Note 1)		39	
I_{AR}	Avalanche current(Note 1)		4.3	
E_{AR}	Repetitive avalanche energy(Note 1)	$I_{AR} = 4.3A, R_{GS} = 50\Omega, V_{GS} = 10V$	1.2	mJ
E_{AS}	Single pulse avalanche energy (Note 2)	$I_{AS} = 4.3A$	235	
dv/dt	MOSFET dv/dt ruggedness		100	V/ns
	Peak diode recovery dv/dt (Note 3)		20	
P_D	Total power dissipation (Derate above $25^\circ C$)	$T_C = 25^\circ C$	TO-220AB 116(0.93)	W(W/ $^\circ C$)
			TO-220F 34(0.27)	
T_J	Operation junction temperature		-55 to 150	
T_{STG}	Storage temperature		-55 to 150	$^\circ C$
T_L	Maximum soldering temperature, for 10 seconds	1.6mm from case	300	
	Mounting torque, #6-32 or M3 screw		10 (1.1)	lbf-in (N·m)

Note: 1. Repetitive rating: pulse width limited by junction temperature.
 2. $I_{AS} = 4.3A, V_{DD} = 50V, R_{GS} = 25\Omega$, starting $T_J = 25^\circ C$.
 3. $I_{SD} \leq 13A, di/dt \leq 200A/\mu s, V_{DD} \leq V_{(BR)DSS}$, starting $T_J = 25^\circ C$.

THERMAL RESISTANCE						
SYMBOL	PARAMETER		Min.	Typ.	Max.	UNIT
$R_{th(j-c)}$	Thermal resistance, junction to case	TO-220AB			1.07	°C/W
		TO-220F			3.7	
$R_{th(j-a)}$	Thermal resistance, junction to ambient	TO-220AB			62.5	°C/W
		TO-220F			62.5	

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise specified)						
SYMBOL	PARAMETER	TEST CONDITIONS	Min.	Typ.	Max.	UNIT
⊙ OFF CHARACTERISTICS						
$V_{(BR)DSS}$	Drain to source breakdown voltage	$I_D = 1\text{mA}, V_{GS} = 0\text{V}$	600			V
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown voltage temperature coefficient	$I_D = 1\text{mA}, V_{DS} = V_{GS}$		0.73		V/°C
I_{DSS}	Drain to source leakage current	$V_{DS} = 600\text{V}, V_{GS} = 0\text{V}, T_C = 25^\circ\text{C}$			10	μA
		$V_{DS} = 480\text{V}, V_{GS} = 0\text{V}, T_C = 125^\circ\text{C}$			100	
I_{GSS}	Gate to source forward leakage current	$V_{GS} = 30\text{V}, V_{DS} = 0\text{V}$			100	nA
	Gate to source reverse leakage current	$V_{GS} = -30\text{V}, V_{DS} = 0\text{V}$			-100	
⊙ ON CHARACTERISTICS						
$R_{DS(ON)}$	Static drain to source on-state resistance	$V_{GS} = 10\text{V}, I_D = 6.5\text{A}$		0.24	0.26	Ω
$V_{GS(TH)}$	Gate threshold voltage	$V_{GS} = V_{DS}, I_D = 250\mu\text{A}$	2		4	V
gfs	Forward transconductance	$V_{DS} = 40\text{V}, I_D = 6.5\text{A}$		16.3		S
⊙ DYNAMIC CHARACTERISTICS						
C_{ISS}	Input capacitance	$V_{DS} = 100\text{V}, V_{GS} = 0\text{V}, f = 1\text{MHz}$		1325	1765	pF
C_{OSS}	Output capacitance		50	65		
C_{RSS}	Reverse transfer capacitance		3	5		
C_{OSS}	Output capacitance	$V_{DS} = 380\text{V}, V_{GS} = 0\text{V}, f = 1\text{MHz}$		30		
$C_{OSS\text{eff}}$	Effective output capacitance	$V_{DS} = 0 \text{ to } 480\text{V}, V_{GS} = 0\text{V}$		145		
Q_G	Total gate charge	$V_{DD} = 380\text{V}, V_{GS} = 10\text{V}$ $I_D = 6.5\text{A}, (\text{Note } 1,2)$		30.5	40	nC
Q_{GS}	Gate to source charge		6.0			
Q_{GD}	Gate to drain charge (Miller charge)		9.5			
ESR	Equivalent series resistance (G-S)	Drain open		2.8		Ω
⊙ SWITCHING CHARACTERISTICS						
$t_{d(ON)}$	Turn-on delay time	$V_{DD} = 380\text{V}, V_{GS} = 10\text{V}$ $I_D = 6.5\text{A}, R_G = 4.7\Omega (\text{Note } 1,2)$		14.5	39	ns
t_r	Rise time		10.5	31.5		
$t_{d(OFF)}$	Turn-off delay time		45	100		
t_f	Fall time		10	30		

SOURCE TO DRAIN DIODE RATINGS AND CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise specified)						
SYMBOL	PARAMETER	TEST CONDITIONS	Min.	Typ.	Max.	UNIT
V_{SD}	Diode forward voltage	$I_{SD} = 6.5\text{A}, V_{GS} = 0\text{V}$			1.2	V
$I_S(I_{SD})$	Continuous source to drain current	Integral reverse P-N junction diode in the MOSFET 			13	A
I_{SM}	Pulsed source current				39	
t_{rr}	Reverse recovery time	$I_{SD} = 6.5\text{A}, V_{GS} = 0\text{V},$ $di_F/dt = 100\text{A}/\mu\text{s}$		280		ns
Q_{rr}	Reverse recovery charge			3.5		μC

Note: 1. Pulse test: Pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$.
 2. Essentially independent of operating temperature.

ORDERING INFORMATION SCHEME

13 N 60 A

Current rating, I_D
 13 = 13A

MOSFET series
 N = N-Channel

Voltage rating, V_{DS}
 60 = 600V

Package type
 A = TO-220AB
 AF = TO-220F

■ TEST CIRCUITS AND WAVEFORMS

Fig.1A Peak diode recovery dv/dt test circuit

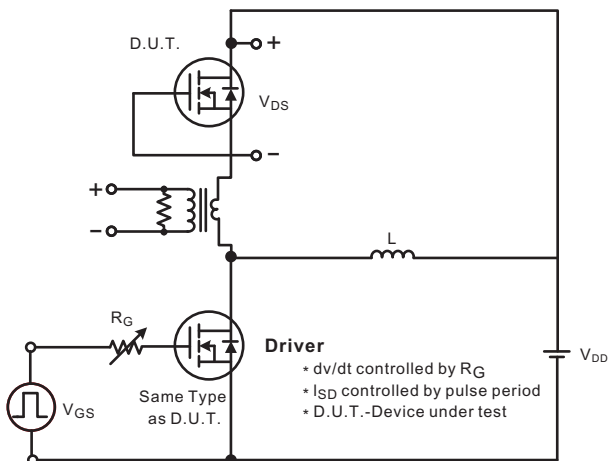
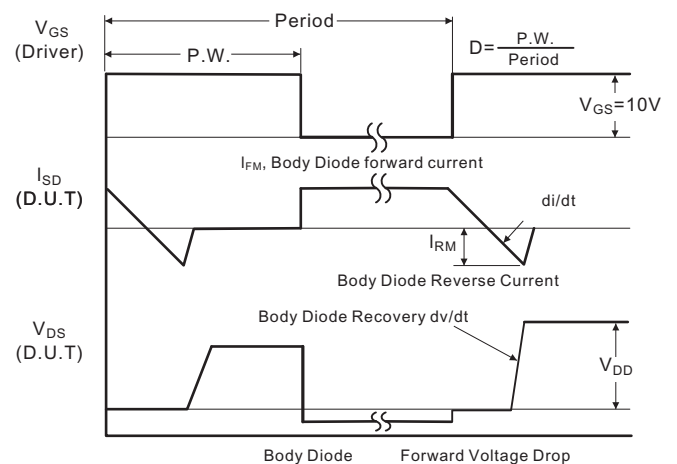


Fig.1B Peak diode recovery dv/dt waveforms



TEST CIRCUITS AND WAVEFORMS (Cont.)

Fig.2A Switching test circuit

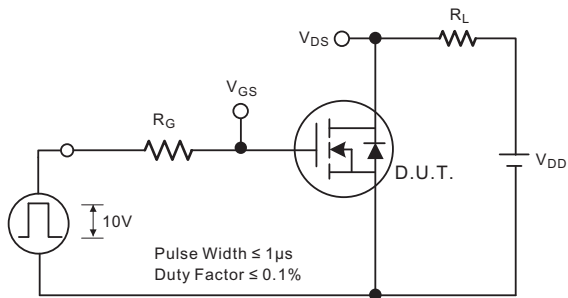


Fig.2B Switching Waveforms

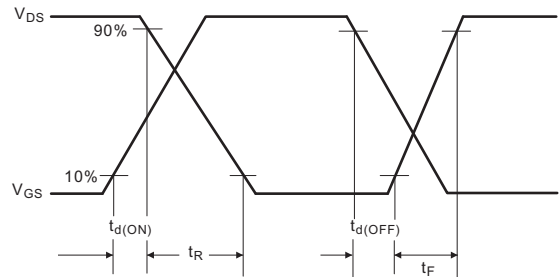


Fig.3A Gate charge test circuit

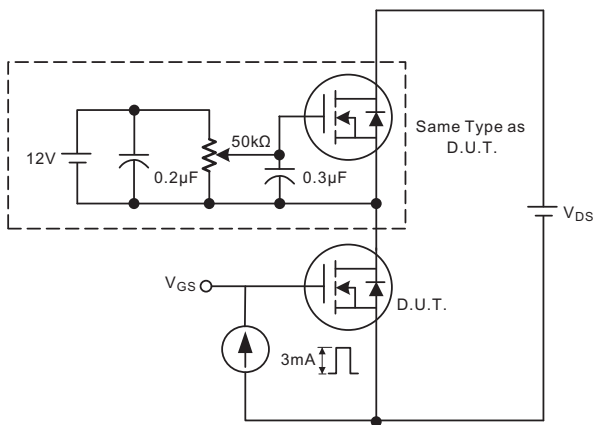


Fig.3B Gate charge waveform

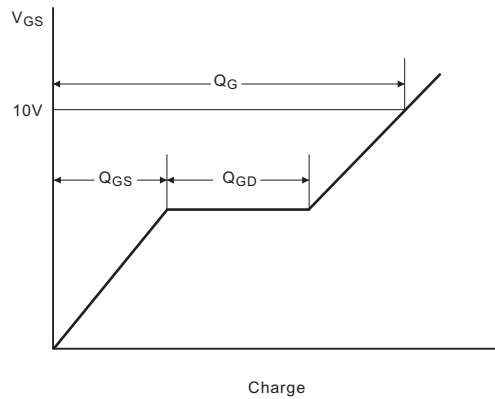


Fig.4A Unclamped Inductive switching test circuit

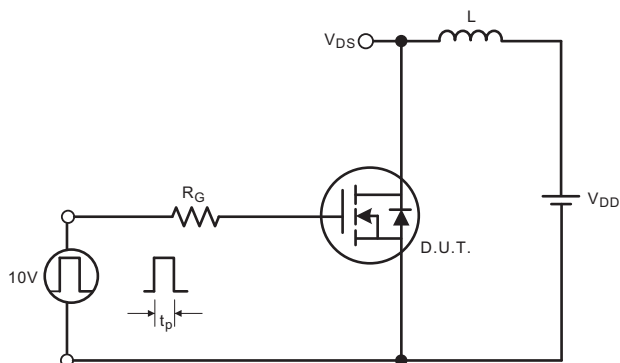
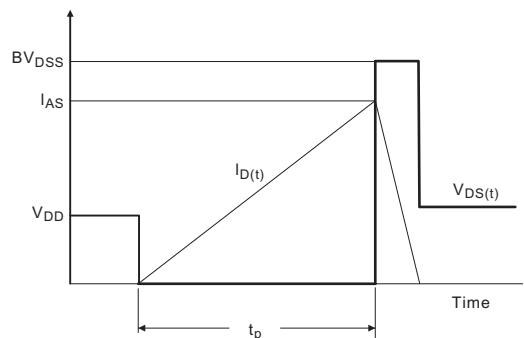


Fig.4B Unclamped Inductive switching waveforms



■ TYPICAL CHARACTERISTICS

Fig.1 On-State characteristics

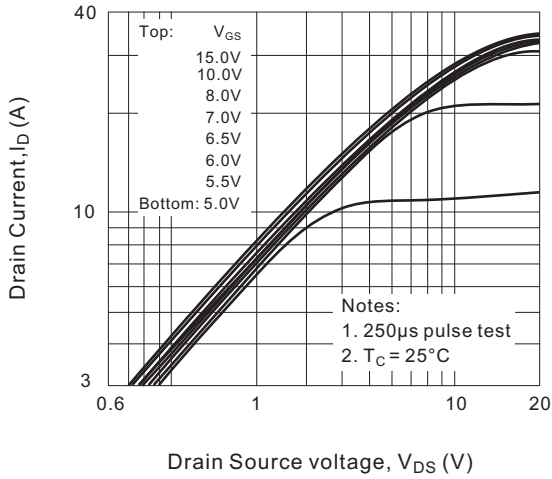


Fig.2 Transfer characteristics

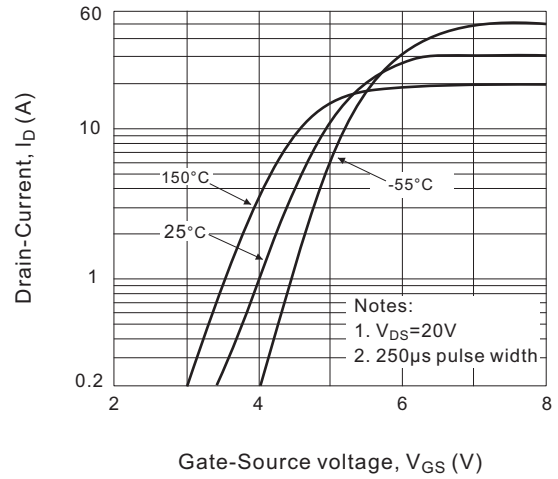


Fig.3 On-Resistance variation vs. Drain current and Gate voltage

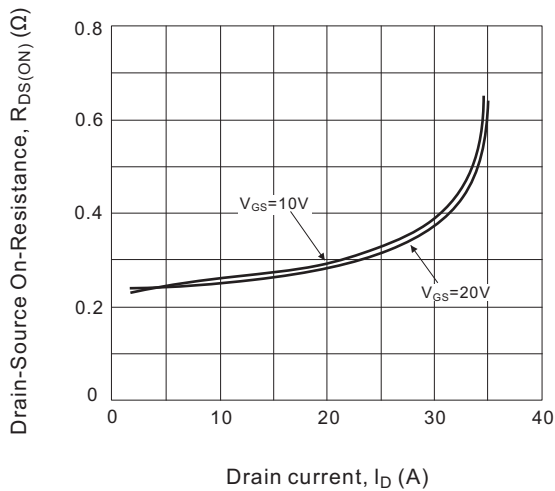


Fig.4 Body diode forward voltage variation vs Source current and Temperature

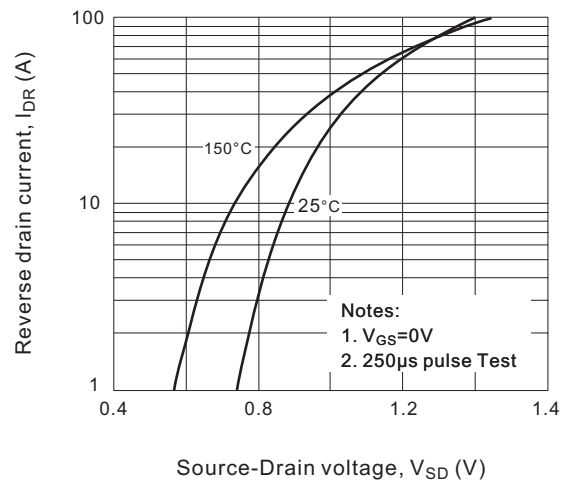


Fig.5 Capacitance characteristics

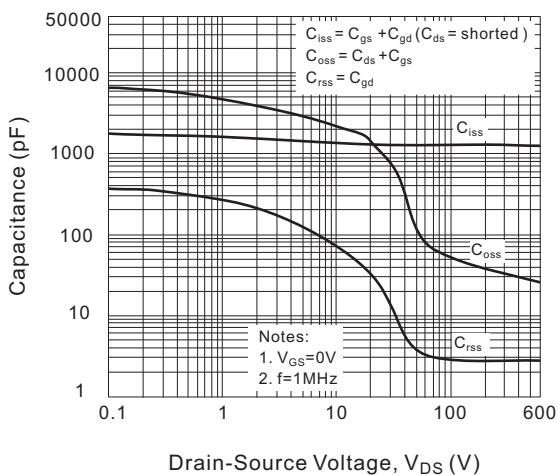


Fig.6 Gate charge characteristics

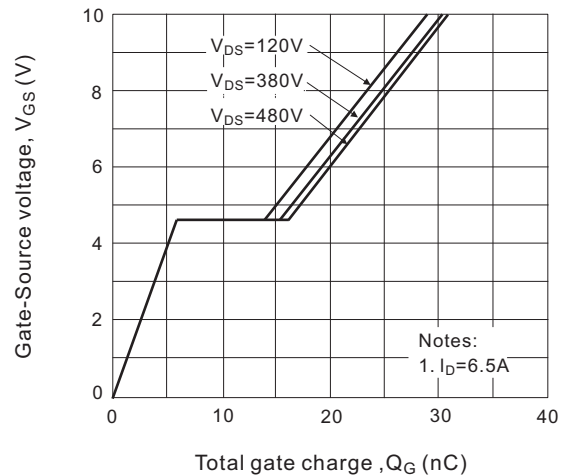


Fig.7a Maximum safe operating area for 13N60A

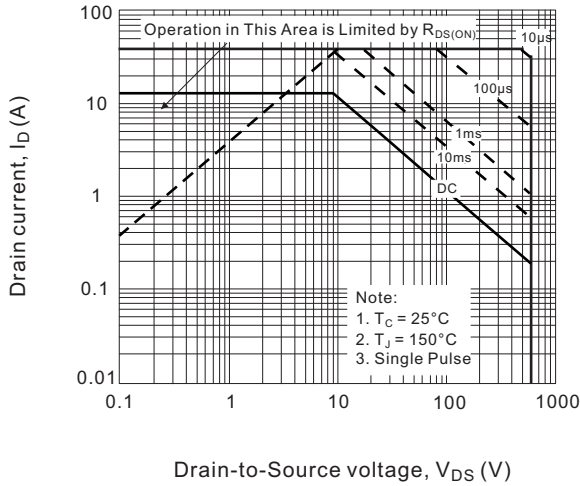


Fig.7b Maximum safe operating area for 13N60AF

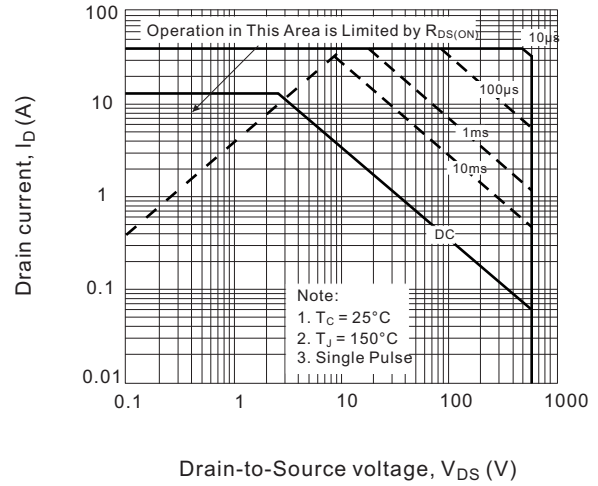


Fig.8a Transient thermal response curve for 13N60A

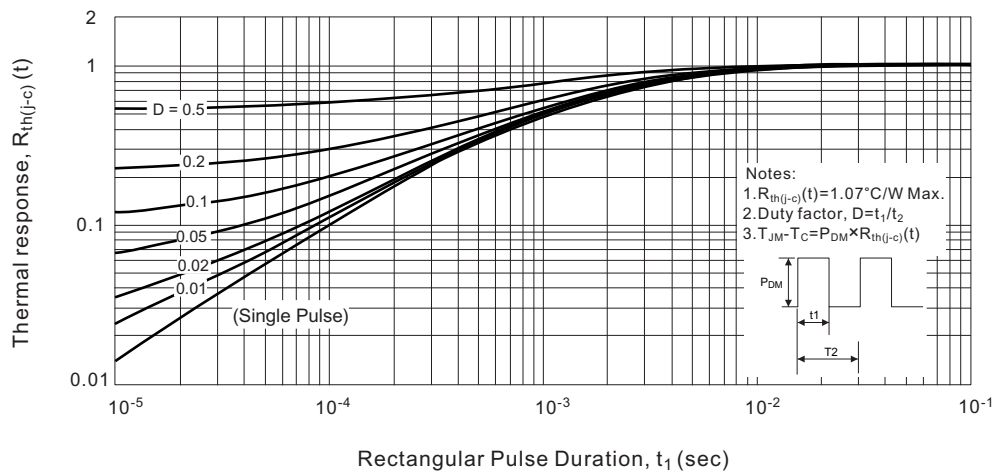


Fig.8b Transient thermal response curve for 13N60AF

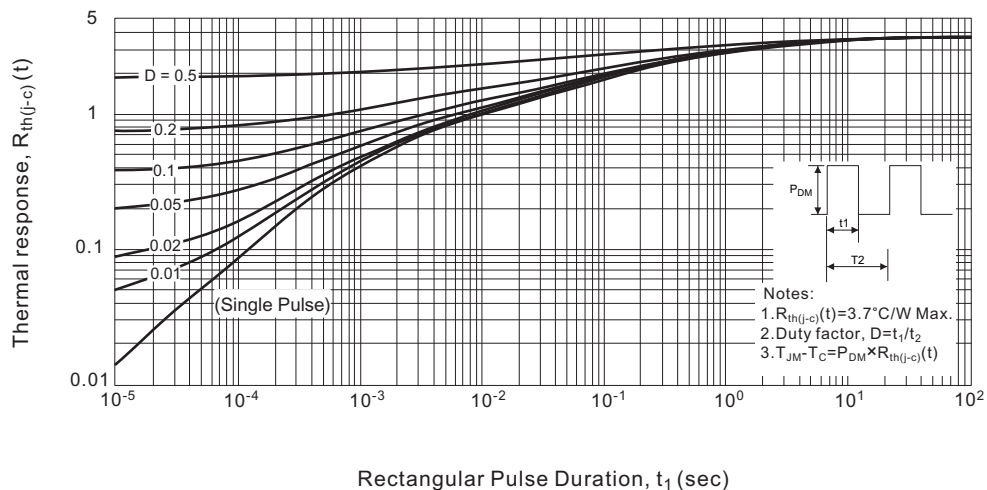


Fig.9 Breakdown voltage variation vs. temperature

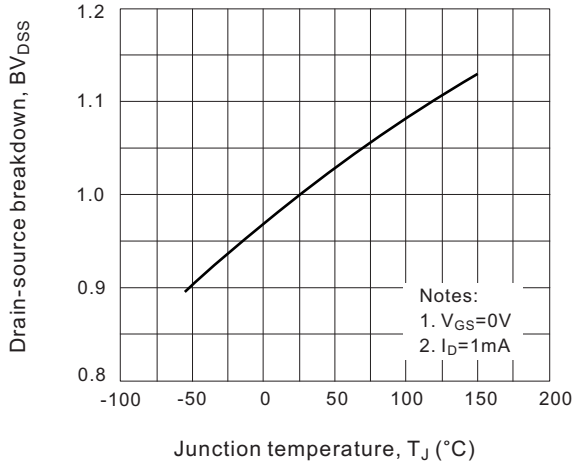


Fig.10 On-resistance variation vs. temperature

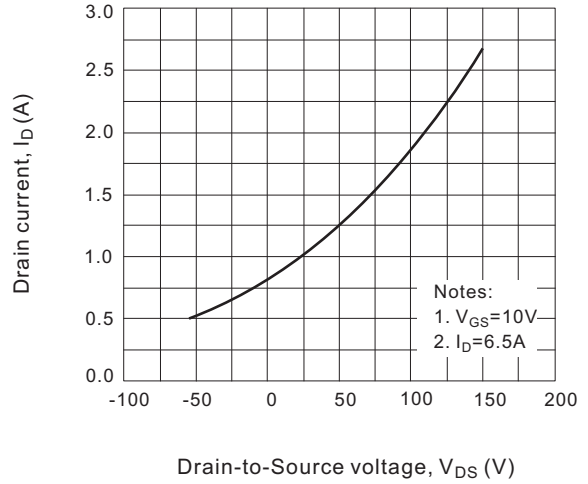
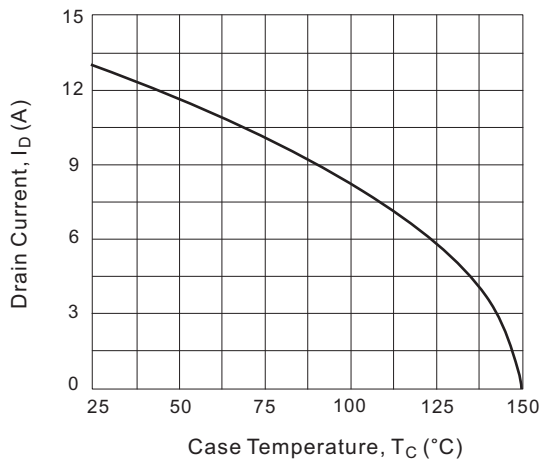
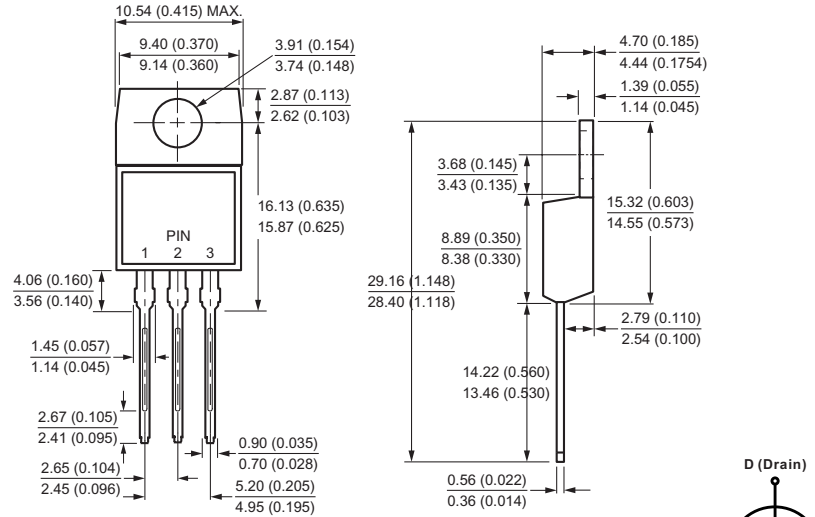


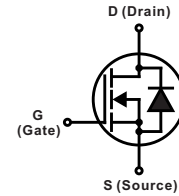
Fig.11 Maximum drain current vs. case temperature



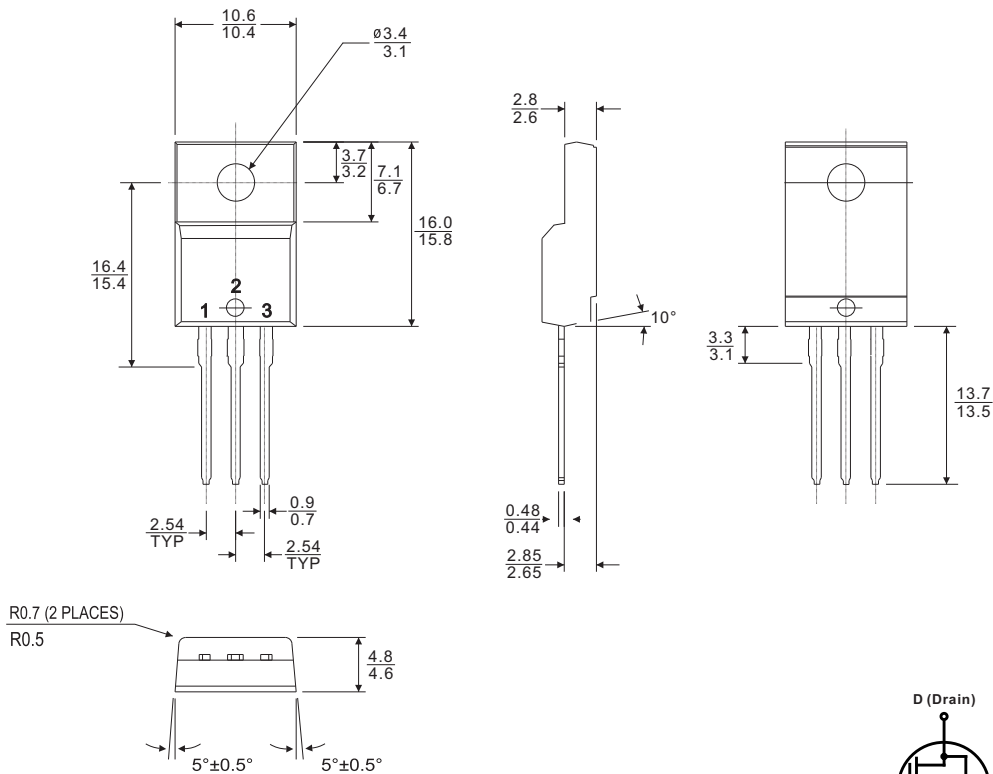
TO-220AB



All dimensions in millimeters(inches)



TO-220F



All dimensions in millimeters

